March, 1960

DIE CASTING ENGINEER

SPUR GEAR DIE DESIGN

Page 9

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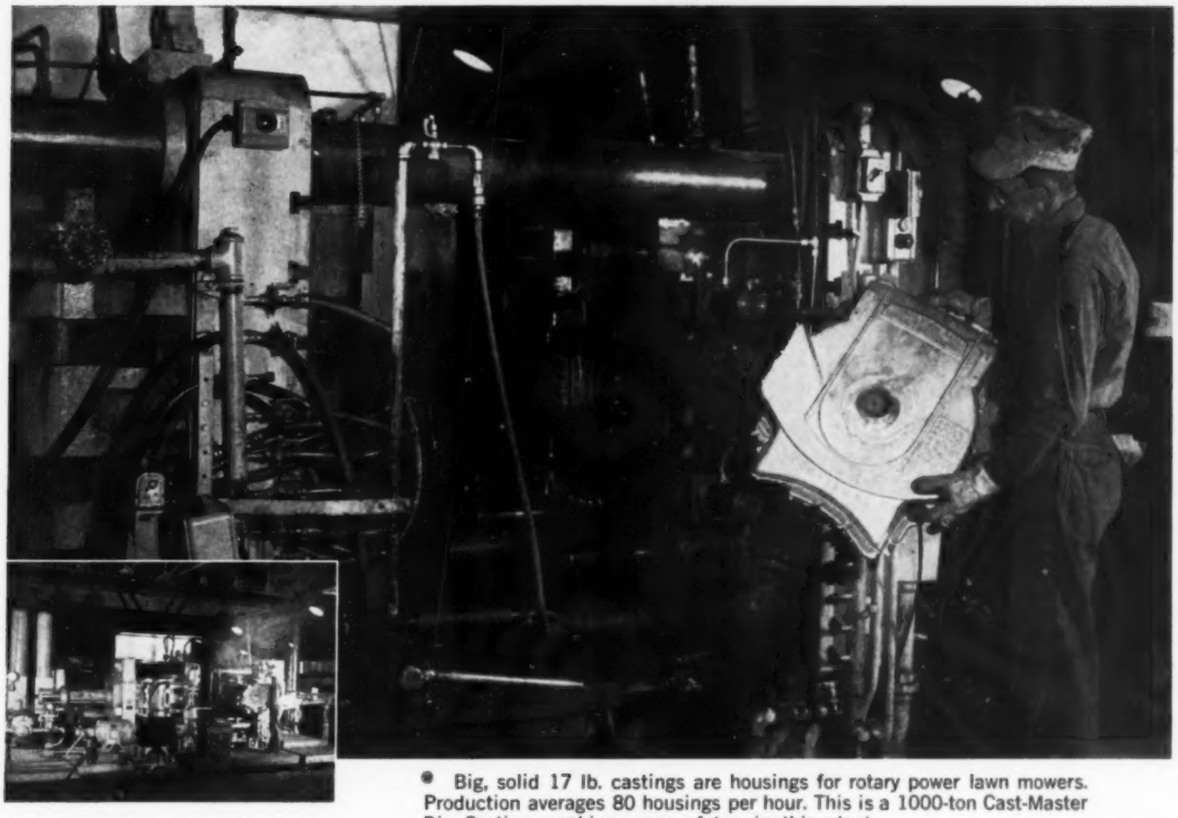

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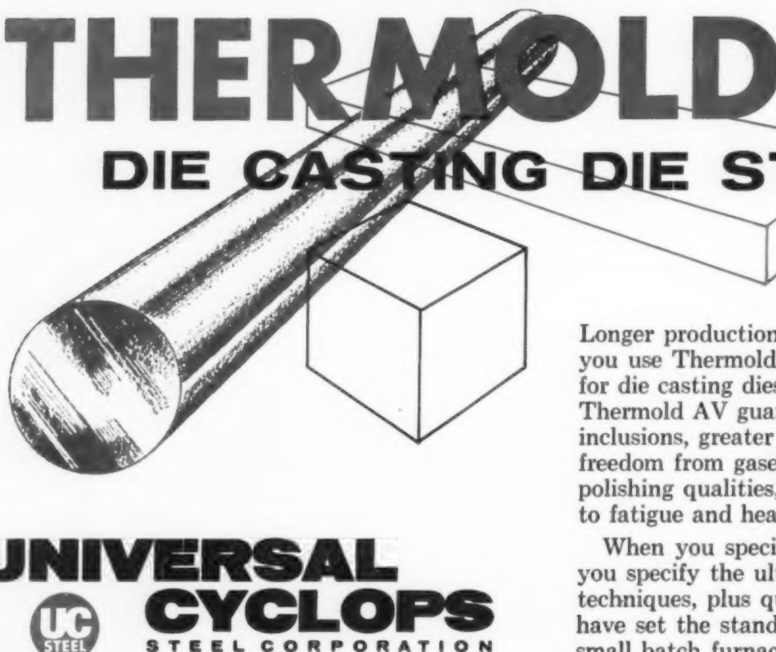

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VOLUME 4
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DIE CASTING ENGINEER

Official Publication of
THE SOCIETY OF DIE CASTING ENGINEERS, INC.

CONTENTS

COVER

A selection of spur gears and geared components. These components may be made inexpensively, in large lots, by the die casting process. Designing a die for a gear is difficult because of the distortion of the gear tooth profile when the cast metal cools and shrinks. *Story on page 9.*

Photo courtesy Camdale Precision, Inc.

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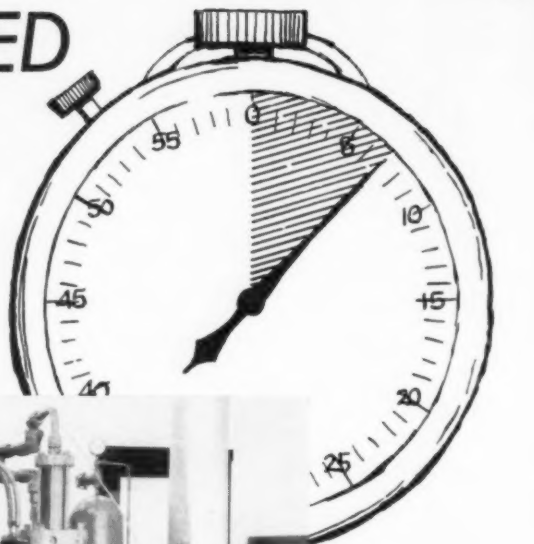
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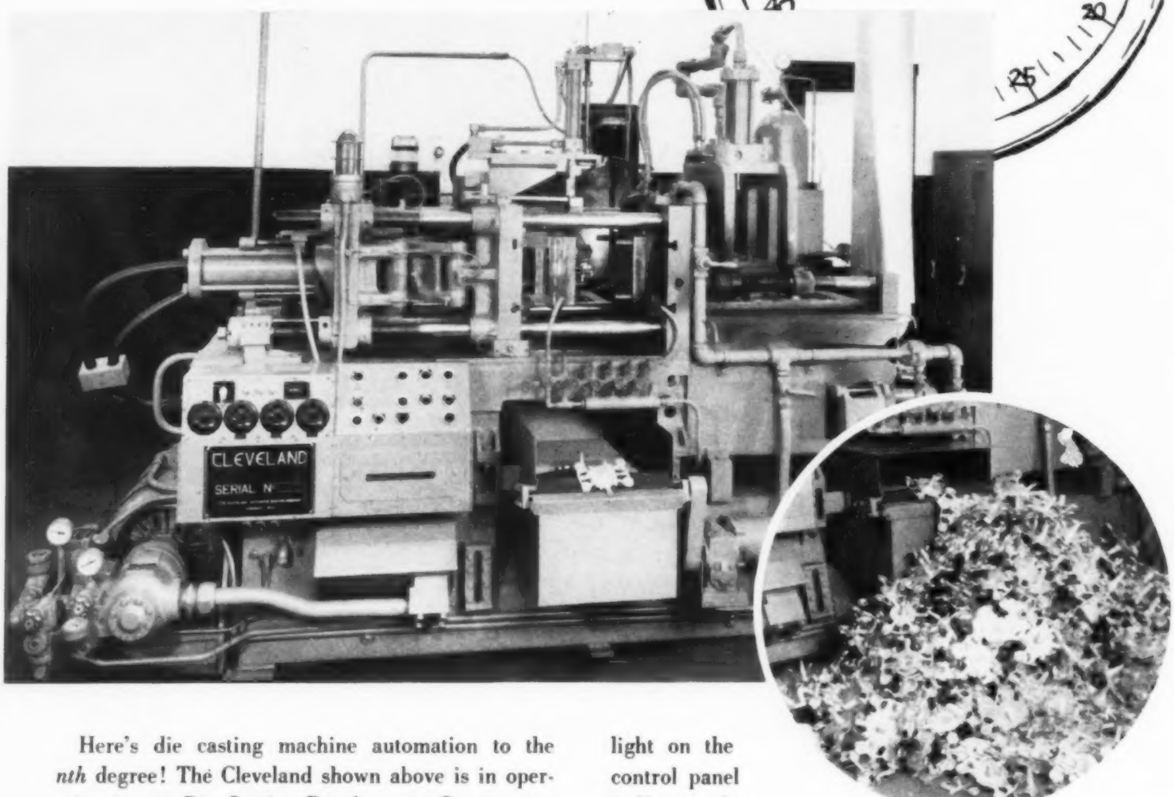
CLEVELAND
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SPUR GEAR DIE DESIGN

by

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GEARS TO BE PRODUCED IN APPRECIABLE QUANTITIES are often die cast with great savings over production by any other means. These savings are effected because in the die casting process precision machining is done only once, on the die. It becomes obvious then that the major responsibility for acceptability of the gear rests with the die designer, not with the die caster.

In almost all gearing applications the ultimate criteria of consumer acceptance is not gear function alone, but gear function and noise level. In most cases gears that are noisy, although they may function satisfactorily, are not acceptable. The ultimate aim of gearing is to have the gears roll as smoothly and quietly as two rolling cylinders.

A low noise level acceptance criterion for a gear places a special burden on the die cast die designer. Experience has established that accurate gears are quiet gears. To meet the consumer demand for quiet gears, the accuracy of a gear may have to be increased beyond the point necessary to meet the functional requirements alone. Of course, a more accurate die must be designed and built to produce a more accurate gear. Die "accuracy" does not imply one-to-one correspondence of the die with the print of the part it forms. The die cast die requires compensatory dimensioning to produce the specified drawing dimensions of the die cast gear.

The engineer who wishes to specify die cast gears should know the limitations as well as the advantages of the die casting process. To realize the advantages of the die casting process, close cooperation between the product design engineer and the die designer is desirable. Often the die designer can make valuable design suggestions to better adapt a contemplated part to die casting; for, in addition to the geometric considerations of the gear to be cast, consideration must also be given to molding variables. The die designer is best able to predict what the molding variables affecting a given gear are going to be and make the proper allowances in the die.

The chief difficulty in die cast gear die design lies in the shrinking of the die cast metal on cooling. The die must be purposely "deformed" to compensate for this shrinkage and produce a perfectly formed gear. This purposeful deformation of the die is not only a diametral correction to correct for the radial shrinkage of the gear, but also a correction in gear tooth profile to accommodate the profile distortion on shrinkage. Figure 1 illustrates the results of compensating for the radial shrinkage of the gear only. The pitch circle of the die cast gear was correctly compensated for, but the gear teeth no longer have the proper involute profile. They show an apparent increase in the pressure angle. The desired tooth profile is indicated by the dashed line. How much die deformation and in what critical areas is a major problem to the die designer.

Many variables affect the shrinkage of a die casting: size and type of die casting machine, size and shape of the die cast part, flow patterns of the metal, sprue and nozzle size, casting cycle, temperature of the die, and the casting alloy. It is the die designer who must evaluate the effect of the die casting variables on the size and shape of the final cast gear. Amount of shrinkage depends on so many variables that its mathematical calculation is difficult from a theoretical standpoint. To derive any correction for the die to compensate for shrinkage, it is first necessary for the die designer to estimate the radial shrinkage of the gear, i.e., the shrinkage of the pitch diameter, from past experience.

Once the shrinkage of the pitch diameter of the gear has been established, it is possible to mathematically estimate the correct pressure angle to be used on the die to produce a gear with the desired pressure angle. The approximating equation for the correct pressure angle is:

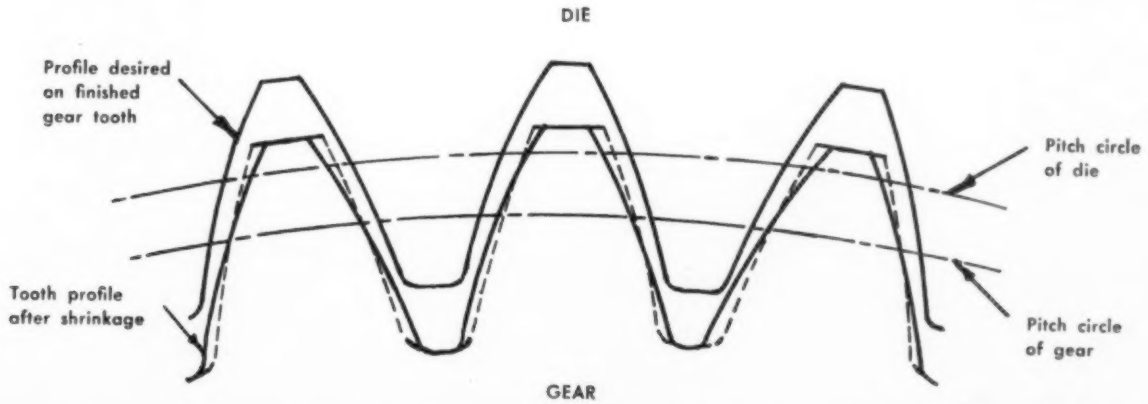


FIGURE 1—An incorrectly designed die. Only the pitch diameter has been enlarged to compensate for radial shrinkage; no compensation was made for distortion of tooth profile. Note that the teeth of the cast gear show an apparent increase in pressure angle. The dashed line shows the tooth profile desired.

$$\phi_d = \text{Cos}^{-1}\left(\frac{D_d \text{ Cos}\phi}{D}\right)$$

ϕ_d = pressure angle of die
D_d = enlarged pitch diameter for computed shrinkage
ϕ = pressure angle desired on cast gear
D = pitch diameter desired on cast gear $\left(\frac{N}{P}\right)$
N = number of teeth
P = diametral pitch

For example, it is desired to die cast a zinc gear, 40 teeth, 20 diametral pitch and 20° pressure angle. The pitch diameter of the desired gear is:

$$D = \frac{N}{P} = \frac{40}{20} = 2.000 \text{ inches}$$

To compensate for radial shrinkage, the die designer estimates that the pitch diameter of the die, D_d, should be 2.0200 inches, allowing for 0.0200 inches shrinkage of the pitch diameter on cooling. Computing the pressure angle required on the die to give the desired 20° pressure angle on the cast gear:

$$\phi_d = \text{Cos}^{-1}\left[\frac{2.0200 \text{ Cos } 20°}{2.0000}\right]$$

$$\phi_d = \text{Cos}^{-1}\left[\frac{(2.0200)\ (0.93969)}{2.0000}\right]$$

$$\phi_d = \text{Cos}^{-1}\left[\ 0.94908\ \right]$$

$$\phi_d = 18°\ 22'$$

Therefore, the pressure angle on the die should be 18° 22′.

The equation for the corrected pressure angle is an approximation using as its basis the departure from its true position of a straight line normal to the line of action at the pitch point. Thus the equation is more accurate where the profile curvature of the gear is flat, as with gears having a large number of teeth rather than with pinions. However, it gives satisfactory results for all practical purposes, and it is simple to use. Generally, no draft is required on the teeth of spur gears because they shrink slightly away from the die walls on cooling, and this further preserves the true involute profile of the gear teeth.

Another problem facing the die designer is that of making the gear teeth as strong as possible. Maximum tooth strength can be obtained by using the largest possible fillet at the root of the tooth. Large fillets eliminate the points of high stress concentration that occur at sharp corners. The difficulty encountered in filleting the roots of the teeth is that the fillets must not interfere with the involute profile needed for the gear to run properly with its mating component. Therefore, it is desirable to know the last point of contact, or the contact diameter, of the mating component with the gear. The contact diameter is identical with the maximum true involute form diameter, or the diameter to which the involute form of the gear teeth must extend. Consider the maximum case for an external gear, the mating of a standard pinion and a standard rack. The rack is the maximum case because it creates the minimum contact diameter. Figure 2 shows the mating condition of a standard pinion and a standard rack, and it illustrates the last point of contact. Also illustrated in Figure 2 is the form of the roots of the gear teeth both with and without filleting.

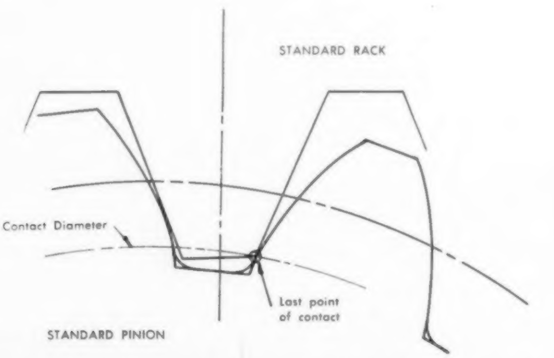


FIGURE 2—Shown are the contact diameter and the last point of contact for a standard pinion mating with a standard rack. Note that the root of the gear tooth is shown with the maximum radius superimposed upon an unradiused root.

Table 1 contains the values of the contact diameters for a standard 20° pressure angle, 1 diametral pitch pinion with from 10 to 200 teeth mating with a standard 20° pressure angle, 1 diametral pitch rack. To obtain the value of the contact diameter for any given diametral pitch, divide the tabulated value for the proper number of teeth by the given diametral pitch. For example, what is the contact diameter of a standard gear with 60 teeth, 20° pressure angle and 8 diametral pitch?

$$N = 60$$

$$\text{from Table 1: } (P)\ (D_c) = 58.2597$$

$$D_c = \frac{58.2597}{P}$$

$$D_c = \frac{58.2597}{8}$$

$$D_c = 7.2824 \text{ inches}$$

The root fillets of the gear teeth may start at a diameter of 7.2824 inches.

Table 2 is presented as a fast means of converting from circular tooth width to chordal tooth width, or vice versa. If the given circular tooth width is at or near the standard value of $\frac{\pi}{2P}$, where P is the diametral pitch, select "A" at the given number of teeth, divide "A" by the diametral pitch and subtract the quotient from the given circular tooth width. The difference is the chordal tooth width. When the chordal tooth width is given, add the quotient, $\frac{\text{"A"}}{P}$, to the chordal tooth width to find the circular tooth width. For example, what is the chordal tooth width of a standard gear with 20 teeth, 20° pressure angle, 6 diametral pitch and a circular tooth width of 0.26180 inches?

$$N = 20$$

$$\text{from Table 2: "A"} = 0.001614$$

$$\frac{\text{"A"}}{P} = 0.000269$$

$$\text{chordal tooth width} = 0.26180 - 0.00027 = 0.26153 \text{ inches}$$

As another example, what is the circular tooth width of a standard gear with 10 teeth, 20° pressure angle, 8 diametral pitch and a chordal tooth width of 0.19635 inches?

$$N = 10$$

$$\text{from Table 2: "A"} = 0.006452$$

$$\frac{\text{"A"}}{P} = 0.000807$$

$$\text{circular tooth width} = 0.19635 + 0.00081 = 0.19716 \text{ inches}$$

The great advantage of die cast gears is that the gears come from the die with all of their teeth of the correct profile and spaced as precisely as a precision made die can cast them. It is the die designer who determines whether the precise die will produce an accurate gear. The charts and equations presented in this article should help him to design an accurate die and shorten his design time.

Editor's Note: *An error was discovered in Figure 1 too late to be corrected in this issue. The leader from the note "profile desired on finished gear tooth" should lead to the dashed line, not to the die.*

TABLE 1

CONTACT DIAMETERS WITH STANDARD 20° PRESSURE ANGLE, 1 DIAMETRAL PITCH RACK.

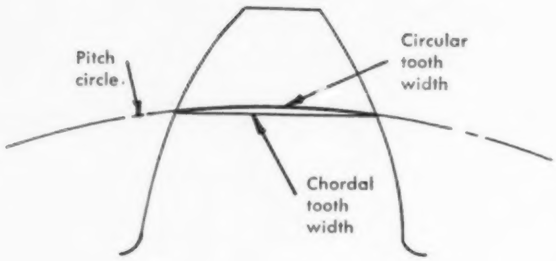
Divide tabular values by given diametral pitch to obtain last point of contact.

N	(P) (D_c)	N	(P) (D_c)	N	(P) (D_c)	N	(P) (D_c)
10	9.7054	58	56.2690	106	104.1451	154	152.0993
11	10.5449	59	57.2643	107	105.1437	155	153.0986
12	11.4103	60	58.2597	108	106.1423	156	154.0980
13	12.2961	61	59.2553	109	107.1410	157	155.0974
14	13.1983	62	60.2511	110	108.1397	158	156.0968
15	14.1136	63	61.2470	111	109.1384	159	157.0961
16	15.0398	64	62.2430	112	110.1372	160	158.0955
17	15.9748	65	63.2392	113	111.1359	161	159.0949
18	16.9173	66	64.2355	114	112.1347	162	160.0943
19	17.8660	67	65.2319	115	113.1335	163	161.0937
20	18.8201	68	66.2284	116	114.1323	164	162.0932
21	19.7786	69	67.2250	117	115.1312	165	163.0926
22	20.7411	70	68.2217	118	116.1301	166	164.0920
23	21.7070	71	69.2185	119	117.1290	167	165.0915
24	22.6759	72	70.2153	120	118.1279	168	166.0909
25	23.6473	73	71.2123	121	119.1268	169	167.0904
26	24.6210	74	72.2094	122	120.1257	170	168.0898
27	25.5968	75	73.2065	123	121.1247	171	169.0893
28	26.5743	76	74.2037	124	122.1237	172	170.0888
29	27.5535	77	75.2010	125	123.1227	173	171.0883
30	28.5341	78	76.1984	126	124.1217	174	172.0878
31	29.5160	79	77.1958	127	125.1207	175	173.0872
32	30.4991	80	78.1933	128	126.1198	176	174.0867
33	31.4832	81	79.1909	129	127.1188	177	175.0862
34	32.4684	82	80.1885	130	128.1179	178	176.0857
35	33.4544	83	81.1862	131	129.1170	179	177.0853
36	34.4412	84	82.1839	132	130.1161	180	178.0848
37	35.4287	85	83.1817	133	131.1152	181	179.0844
38	36.4169	86	84.1795	134	132.1143	182	180.0839
39	37.4058	87	85.1774	135	133.1135	183	181.0835
40	38.3952	88	86.1754	136	134.1126	184	182.0830
41	39.3852	89	87.1734	137	135.1118	185	183.0826
42	40.3757	90	88.1714	138	136.1109	186	184.0821
43	41.3666	91	89.1695	139	137.1101	187	185.0817
44	42.3579	92	90.1676	140	138.1094	188	186.0812
45	43.3497	93	91.1657	141	139.1086	189	187.0807
46	44.3418	94	92.1640	142	140.1078	190	188.0803
47	45.3343	95	93.1622	143	141.1071	191	189.0798
48	46.3270	96	94.1605	144	142.1063	192	190.0794
49	47.3201	97	95.1588	145	143.1055	193	191.0790
50	48.3135	98	96.1571	146	144.1048	194	192.0785
51	49.3071	99	97.1555	147	145.1041	195	193.0781
52	50.3010	100	98.1539	148	146.1034	196	194.0778
53	51.2952	101	99.1524	149	147.1027	197	195.0774
54	52.2895	102	100.1509	150	148.1020	198	196.0770
55	53.2841	103	101.1494	151	149.1013	199	197.0766
56	54.2789	104	102.1479	152	150.1006	200	198.0762
57	55.2738	105	103.1464	153	151.0999		

N=number of teeth
P=diametral pitch
D_c=contact diameter

TABLE 2

TOOTH WIDTH CONVERSION



If the given circular tooth width is at or near the standard value of $\frac{\pi}{2P}$, where P is the diametral pitch, select "A" at the given number of teeth, divide "A" by the diametral pitch and subtract the quotient from the given circular tooth width. The difference is the chordal tooth width. When the chordal tooth width is given, add the quotient, $\frac{\text{"A"}}{P}$, to the chordal tooth width to find the circular tcoth width.

"A" = circular tooth width — chordal tooth width for one diametral pitch.

NUMBER OF TEETH	"A"	NUMBER OF TEETH	"A"	NUMBER OF TEETH	"A"	NUMBER OF TEETH	"A"
3	.070796	28	.000824	53	.000230	78	.000106
4	.040063	29	.000768	54	.000222	79	.000103
5	.025711	30	.000718	55	.000214	80	.000101
6	.017882	31	.000672	56	.000206	81	.000099
7	.013150	32	.000631	57	.000199	82	.000096
8	.010074	33	.000593	58	.000192	83	.000094
9	.007963	34	.000559	59	.000186	84	.000092
10	.006452	35	.000527	60	.000179	85	.000089
11	.005333	36	.000498	61	.000174	86	.000087
12	.004482	37	.000472	62	.000168	87	.000085
13	.003819	38	.000447	63	.000163	88	.000083
14	.003294	39	.000425	64	.000158	89	.000082
15	.002869	40	.000404	65	.000153	90	.000080
16	.002522	41	.000384	66	.000148	91	.000078
17	.002234	42	.000366	67	.000144	92	.000076
18	.001993	43	.000349	68	.000140	93	.000075
19	.001789	44	.000334	69	.000136	94	.000073
20	.001614	45	.000319	70	.000132	95	.000072
21	.001464	46	.000305	71	.000128	96	.000070
22	.001334	47	.000292	72	.000125	97	.000069
23	.001221	48	.000280	73	.000121	98	.000067
24	.001121	49	.000269	74	.000118	99	.000066
25	.001033	50	.000258	75	.000115	100	.000065
26	.000955	51	.000248	76	.000112		
27	.000886	52	.000239	77	.000109		

A hedge around your inventions . . .

UNITED STATES PATENT

ARTICLE I, SECTION 8 OF THE UNITED STATES CONSTITUTION authorizes congress ". . . To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries; . . . ." This portion of the Constitution is the foundation for our present patent laws.

United States letters patent, commonly called United States patent, is a document issued by the United States Patent Office stating the exclusive right of an inventor to the disposition of his invention for a period of seventeen years. However, a patent does not necessarily give the inventor the right to make or sell his own invention. This is particularly true in the case where an inventor obtains a patent for improvements on a device or process that is already covered by a patent. The patent gives the inventor the rights to the improvement, but he may not make or sell his invention without the permission of the holder of the patent on the basic device or process. The patent on the improvement is dominated by the patent on the basic device or process.

In essence, a patent grants to the inventor a seventeen year monopoly on his invention. Monopolies are generally considered detrimental to the public interest because they restrain commerce, and they are illegal under the provisions of the Sherman Anti-Trust Act, with some exceptions. But, in the case of patents, a monopoly is justified because the commerce they restrain did not exist before the invention. Also, patent monopoly encourages the research and development that leads to inventions, and it encourages the public disclosure of technological achievements. After the expiration of the seventeen year monopoly, the invention becomes public domain, and its use is free to all.

Patents vary in form, but most patents contain the following essentials: a title, the names of the inventors and assignees, a statement of the field to which the patent applies, a statement of the problem solved by the invention, a statement of how the invention solves the problem, a drawing of the invention and a description of the drawing, a detailed description of the invention, a legal description of the invention and a list of references cited by the Patent Office during the period when the patent was pending.

The legal description of the invention is the heart of the patent, and it is known as the patent claims. These claims define the scope of the invention, or the area of the technology which the inventor wishes to reserve for himself. It is obvious that the broader the claims the greater the advantage the patent offers the inventor. Many patents contain a multitude of claims, some broad and some rather narrow, and the scope of all the claims will not be concentric. Multiple claims are desirable because should the broad claims later be found invalid, the invention may still be protected by the narrower claims.

Having broadly discussed what a patent is, let us now consider what may be patented. There are four specific requirements and one general requirement which a patent must satisfy. The four general requirements are: the invention must be within the bounds of subjects considered patentable, the invention must be novel, the invention must be useful and the invention must not have been obvious. The general requirement is that the invention must not be subject to any of the specific instances of non-patentability cited in our patent laws.

Subjects considered patentable in our present patent laws are processes, machines, manufactures, compositions of matter, plants and ornamental designs.

A patentable invention must be useful to some extent for a lawful purpose. However, the invention does not necessarily have to be economically practicable.

For an invention to meet the novelty requirement for patentability it must not have been known by others in this country, or patented or described by others in a printed publication in this or a foreign country before the application for a patent. A printed publication is construed to mean a publication available to the public regardless of the method of publication. It also includes commercial catalogs and brochures.

Requiring that an invention must not have been obvious at its inception is one of the most illusive requirements for patentability. The degree of obviousness in many cases is a personal prejudice. In determining patentability, the invention must not have been obvious to a person skilled in the art to which the invention is applied.

Let us now look at some of the specific instances of non-patentability cited in the patent laws. The invention cannot have been used commercially or printed in a publication in this country or a foreign country more than one year before the application for a patent was filed. This requirement differs from the novelty requirement in that the novelty requirement states use or publication by others, this requirement includes use or publication by the inventor.

An invention is not patentable if it has been abandoned. Abandonment of an invention does not mean that the inventor has simply neglected to apply for a patent for some long period of time. A patent is considered abandoned only after the inventor demonstrates by some positive act that he considers his invention worthless.

If the inventor has been granted a foreign patent on his invention, or if he has applied for a foreign patent twelve

months prior to applying for a U.S. patent, his invention is not patentable. An invention is not patentable if it is described in a patent already issued, or described in an application for a patent filed before the invention was made by another person seeking to patent it.

A patent will only be granted to the inventor. If a patent is issued to someone who is not the true inventor, then the patent is held to be invalid.

There are certain other tests applied to an invention which, while not so stated in law, are criteria of the patentability of the invention. Simple changes in size or purity of common items are not patentable unless they effect a change in function out of proportion to the change in size or purity. For example, it was possible to obtain composition patents on transistor materials even though the differences between a transistor and pure germanium were only small changes in purity.

An aggregation of familiar objects is not patentable, a combination is patentable. An aggregation is defined as an assembly of two or more familiar objects, the assembly not being capable of doing anything the series of individuals was not able to do. A combination is an assembly of two or more familiar objects capable of performing functions the combination or individuals was not. Therefore, to be patentable, an assembly of familiar objects must possess some capability not possessed by the individual components.

If an inventor feels that his invention is patentable as far as he can determine, the next step is to file an application for a patent. Although the inventor can file his own application, it is more usual for him to consult a patent attorney. Many patent attorneys are skilled in another field of endeavor besides patent law, and it is an obvious advantage to the inventor to secure a patent attorney who is also skilled in the field to which the patent pertains. In any case, the attorney will have the inventor disclose to him the full details of the invention, the state of the art prior to the invention and all the possible ramifications of the invention. At this point the attorney may do some research to further familiarize himself with the invention and its associated art.

The next step is the most important in protecting the invention. The attorney and the inventor will get together to formulate the patent claims. Both the broad and narrow aspects of the invention will be discussed, and the attorney will formulate the claims to give the inventor maximum legal protection.

A patent search may be instituted by the attorney to see if the claims are patentable. A patent search involves searching through the files of the patents previously issued by the U.S. Patent Office and determining if any of the valid claims therein conflict with the claims of the client. This search is made easier by a unique classification system of the Patent Office which sorts the patents issued by the arts and their subclassifications. Following the patent search, the attorney and the inventor may discuss the probable economic gain from the invention, and the inventor must decide if the gain justifies the further expenses of proceeding with the patent application.

Assuming that it is desired to continue, an application for a patent is filed. The application contains the same essentials as were listed above for a patent and, in addition, an oath by the inventor (or inventors) that he believes himself to be the original inventor of the invention claimed in the application, a power of attorney if an attorney is being used, a petition or request that a patent be granted and a filing fee.

When the application reaches the Patent Office it is checked for clerical errors, and, if satisfactory, it is given a serial number and a filing date. The filing date is the date the application was received by the Patent Office. The filing date and the serial number are very important to the inventor should any person later claim to have made the invention first.

At the Patent Office the application is turned over to a patent examiner who is very often a specialist in the field to which the patent applies. The examiner will examine the claims in the patent application and then prepare an office action in which each claim is separately allowed or rejected. References to other patents that the examiner believes to pertain to the invention may also be included in the office action. Results of the office action are then returned to the inventor or to the person he designates as his attorney.

After receipt of the results of the office action the inventor or his attorney have a period of six months to make any changes they wish in the application claims or give the reasons they believe that a rejected claim should be allowed. The examination sequence may be repeated several times before the individual claims are finally allowed or rejected by the patent examiner. If any claims are rejected, the inventor still has recourse to appeal the decision in the courts.

If the patent claims are allowed, the applicant is so notified by the Patent Office. The inventor then has six months in which to pay the final patent fee. Upon payment of the fee, the patent application is readied for the printing of the final patent document.

A short time after payment of the final fee the patent is printed, or issued, and a copy is sent to the inventor or his attorney. Only after the patent has been issued may the inventor stop anyone from using his invention.

Once a patent has been issued, it is completely out of the hands of the Patent Office. It is then up to the inventor and the courts to protect the invention to the letter of the law.

NATIONAL DIE CASTING EXPOSITION AND CONGRESS

Within four weeks of the mailing of brochures for the 1960 National Die Casting Exposition and Congress, more than 20 per cent of the space had been sold. At the time of publication of this issue, the figure has risen to 30 per cent with a total of 28 exhibitors having made reservations.

This early interest in our show points to a most successful affair.

All members of the SDCE are now being brought into a program of active space solicitation. This will permit members to assist in building the show and also provide some income in the form of commissions for the Society. See your chapter show coordinator for complete details.

Last fall a questionnaire was mailed to all members asking for opinions concerning the show. The results were overwhelmingly in favor of holding an Exposition in Detroit. Virtually all respondents indicated strong interest in attending. The number of companies indicating they would exhibit was more than one third of the total number of spaces available in our present floor layout. This type of preselling was tangible early evidence of show success before our promotion efforts were started.

A most interesting portion of the survey dealt with answers to questions regarding conference topic preference. The following is a list of subjects along with the per cent of interest indicated:

Die Design	16 per cent
Vacuum Die Casting	13 per cent
Anodizable Aluminum Die Castings	8 per cent
Die Steels	7 per cent
Die Casting Equipment	7 per cent
Finishing of Castings	7 per cent
Lubricants	6 per cent
Die Casting Automation	3 per cent
Die Casting Alloys	4 per cent

The balance of the preference was divided in order among metal handling and treating, machining of dies, standards, cost control, new markets, machining of die castings, large die castings and part design.

The above topics will be the basis for our technical conference. A competent committee has been appointed by our Congress manager Harry Hall, to obtain papers of top interest to the die casting field.

This committee first met as a group at a meeting at the Engineering Society of Detroit on Dec. 9, 1959. It is made up of:

Peter Ponta—Ford Motor Co.
Donald Colwell—Apex Smelting Co.
Earl Mason—Consultants to Industry, Inc.
Joseph Rayniak, Jr.—Outboard Marine Corp.

We have already received indication of cooperative support of our technical program from four leading trade associations in the die casting metals field. Through this cooperation we will be assured of the best possible subject coverage in the metals area.

Ralph West, house chairman, has already reserved 2,000 rooms in the six leading Detroit hotels. The headquarters hotel will be the Sheraton-Cadillac.

A banquet is planned for Thursday,

November 10, the evening before the last day of the show. An outstanding speaker will give his views on the die casting industry.

Mac Nichols is actively organizing our publicity program to provide an effort of maximum effectiveness.

Each month 235 trade publications and newspapers are receiving news releases on the show. Many trade publications in the die casting and allied metalworking and metals fields are indicating interest in the Exposition.

Art Clark and his committee have developed an exhibition prospect list of more than 1200 companies to which our brochures have been mailed. Each month a mailing piece will be sent out to follow up the brochure mailing.

THIRD INTERNATIONAL PRESSURE DIE CASTING CONFERENCE

The committee is pleased to announce that the European Tour is filled and a SAS DC-7C airplane reserved for the flight to London and from Rome. The European plant trips have been fully arranged through the efforts of Earl Mason, the Technical Director of the SDCE. Applications are still being accepted for the waiting list in event of cancellations.

1960 OFFICERS

President: Ollie Clayton*
Vice-President: James L. Sutton*
Sec'y-Treasurer: Meyer R. Tenenbaum
Directors:
Glen L. Boxell*
Joseph R. Elkins*
John B. Fisher*
Clarence Tice*
John T. Weston
Herman J. Windolph

Newly elected officers.

Ollie Clayton has been active within the S.D.C.E. since shortly after its inception. He has held the offices of Secretary-Treasurer of the Detroit-Saginaw Valley Chapter, National Director, and is now the fifth President of the Society.

Mr. Clayton learned patternmaking in high school and took mechanical engineering at Virginia Polytechnic Institute. His work history includes sand casting, product development, Ass't Chief Engineer of an Aluminum and Magnesium die casting plant and General Manager of a die cast die shop, and he is presently Chief Engineer, Die Cast Tooling Division, Efficient Tool and Die Co. in Cleveland, Ohio.

Ollie brings to the Society an extensive knowledge of the purpose and background of the S.D.C.E., and a strong desire for the Society to be a leader in technical advances in the die casting industry.

With his background and this desire we can be assured of continuation of purpose and of further growth of our Society.

James L. Sutton for the past five years has been General Superintendent for Dura Division of the Detroit Harvester Company. Prior to this, he was General Superintendent with the Whirlpool Corporation. Mr. Sutton is Chairman of the Toledo Chapter of the SDCE.

Glen L. Boxell has been associated with tools and dies for thirty-six years, and he has had direct responsibility for die casting tooling for eighteen years. Mr. Boxell is currently Senior Tool Engineer at the Delco-Remy Division of GMC in Kokomo, Indiana, and he has worked on the G.M. Master Mechanics Die Casting Committee. In 1958 he served the Indiana Chapter as Treasurer.

Clarence Tice graduated from Purdue University with a B.S. in Mechanical Engineering and a major in aeronautical design. He has been with Delco-Remy Division of GMC since graduation, and he is presently Master Mechanic responsible for plants in the Indiana area. Mr. Tice has been active on the Standards Committee of the SDCE.

Joseph R. Elkins majored in mechanical engineering at Polytechnical Institute in Brooklyn. He is presently President of J. R. Elkins, Inc., a position he has held for twelve years. Mr. Elkins is now completing his second year as Chairman of the New York Chapter.

John B. Fisher completed the tool and die apprenticeship program at A.C. Spark Plug Division of GMC, and he also attended GM Institute and Flint Junior College. He is presently Supervisor in charge of tool engineering at the Chrysler Casting Plant. Mr. Fisher served as Vice-Chairman of the Indiana Chapter, and he is currently a Trustee of that Chapter.

NEW CHAPTER

The Society of Die Casting Engineers, Inc., is proud to announce a healthy new chapter. This is to be known as Saginaw Valley, Chapter 2.

At a well attended meeting on Wednesday, February 17, 1960, the following men were elected to guide this chapter through the coming year.

Chairman: Roy Lehn, Ternstedt Division, GMC.

Vice-Chairman: Ray Smith, Saginaw Bay Industries.

Sec'y-Treas.: Robert Peters, Ternstedt Division, GMC.

Hist. & Lib.: Robert McKee, Chevrolet Division, GMC.

NEW BOOKS

Progress in Vacuum Science and Technology — A. S. D. BARRET, Editor. 160 pages. Pergamon Press, Inc., 122 East 55th Street, New York 22, New York. 1959. $10.00.

"A full understanding of vacuum technology in all its aspects and a possible participation in the development of that science is no longer a matter of being familiar with some related elementary physical phenomena and a few apparatus designed for their application. To prove this, one needs only remember the multitude of major innovations made recently in the field of vacuum practice. Briefly these are, the gas-ballast pump, the Roots pump, the introduction of low-vapour pressure pump fluids, the latest developments in ionization gauges, the alphatron, the omegatron, various leak-testing procedures, ultra-high vacuum techniques, the construction of plants for experimental nuclear physics and the rapid advances in vacuum metallurgy,' writes J. Yarwood, M. Sc., F. Inst. P., of the Department of Mathematics and Physics at the Polytechnic, London. His is the opening article in this progress report, and he deals with education in vacuum practice at colleges in the United Kingdom, revealing the extent of penetration into college curriculum on undergraduate and graduate levels.

The progress report embraces six other papers by avant-garde researchers and authorities on industrial manufacture, drying, distillation and metallurgy, each paper marking the advance in vacuum science in recent times. N. W. Robinson, A.R.C.S., Ph.D., writes on *Vacuum Problems in the Valve Industry;* P. della Porte, Dr. Ing., on *The Gettering Process;* A. E. Franks, B. Met. Eng., on *Vacuum Metallurgy in the U.S.;* W. Burns Brown, M. Sc., on *Vacuum Fumigation;* E. W. Flosdorf and Samuel Tease on *Vacuum Drying;* P. Ridgway Watt, B. Sc., on *Molecular Distillation.* — Robert Trochet.

Problems of Low Temperature Physics and Thermodynamics —PROCEEDINGS OF THE MEETING OF COMMISSION OF THE INTERNATIONAL INSTITUTE OF REFRIGERATION, DELFT (The Netherlands). 1958. 341 pages, not indexed. Pergamon Press, Inc., 122 East 55th Street, New York 22, New York. 1959. $11.50.

Attainment of low temperatures and the taking of measurements and conducting investigations at these temperatures are concerns of cryogenics. The missile in our time makes cryogenic inquiry urgent where formerly it was only important. Electronic computer development adds to the urgency. The classical devices for low temperature measurement are the helium gas thermometer and the platinum resistance thermometer. Cheaper, more sensitive devices are demanded, and the demand comes chiefly from the chemical and electronic industries. Missiles require componentry capable of sustaining liquid oxygen temperatures of cosmic space. Low temperature sensing elements must be small, produce a large electrical output, offer the possibility to measure their output with rugged instruments. Thermistors, as temperature sensitive resistors with high negative temperature coefficient of resistance, have been adapted for this purpose. They are made of semiconducting materials such as oxides, sulfides or intermettalic compounds.

Superconductors are sought for high speed computer circuitry for larger and faster electronic computers. Size, speed and cost of available memory elements limit the possibility of satisfying the demand for the development of the larger and faster computers, but superconducting circuitry appears to offer hope.

The *Problems of Low Temperature Physics and Thermodynamics,* is frontier talk about cryogenic apparatus, thermometry, the disturbed crystal lattice, transport phenomena in liquids and gases. Forty papers, some untranslated from the French, make up this book of warm interest in cold matters.—*Robert Trochet.*

Process Instruments and Controls Handbook – DOUGLAS M. CONSIDINE, Editor. 1383 pages. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York. 1957. $19.50.

"Instrumentation is the art or science of applying measuring devices or measuring and controlling devices to . . . a system for the purpose of determining the identity and/or magnitude of certain varying physical or chemical quantities, and often for the purpose of controlling those quantities within specified limits." The *Process Instruments and Controls Handbook* so defines instrumentation on the first page of the first chapter, and it carries on from there with a comprehensive coverage of the theory, techniques and instruments for performing every important instrumentation and control function in both process and non-process industries.

This volume probably has the most comprehensive coverage of the science of instrumentation between two covers. Full chapters are devoted to each of the more common types of measurement; temperature, pressure, flow, liquid level and chemical composition. Similarly, measuring instruments, automatic controllers and final control elements are each discussed in separate chapters. The chapter on principles of automatic control serves as an excellent refresher and reference source for those knowledgeable in instrumentation theory, and it can serve as a text for those more pedestrian.

The Casting of Steel – W. C. Newell, Editor. 599 pages. Philosophical Library, 15 East Fortieth Street, New York 16, New York. 1957. $22.50.

The former head of the Steel Castings Division of the British Iron and Steel Research Association, Doctor W. C. Newell, apologizes in his editor's preface for gaps he should have liked to seen filled in the effort at a "balanced view of the whole subject" of *The Casting of Steel*. The gaps are there, he says, because authoritative experts are busy people and the book had to be kept within reasonable compass.

The busy experts concerned themselves with basic principles and their practical outworkings in the solutions of problems of the steel casting industry and, busy or not, their writing fully reveals their expertness. They have provided a book that guides steel founders and engineers, reliably, sure-footedly through the technical brambles of the industry, marking the way with photos, illustrations, graphs and charts sufficient to make matters clear, even to those innocent of experience in the industry–which, of course, is the method that distinguishes the expert every time.

Thirteen chapters, excellently indexed, provide the reasonable compass of the book. They deal with The Properties of the Liquid Metal, The Mechanism of Solidification, The Melting Process, The Use of Refractories, Pattern Making, Mold Preparation and Core Making, Casting Into Sand Molds, Centrifugal Formation of Castings, The Investment Casting Process, The Heat Treatment and Properties of Steel Castings, Mechanical Testing, Radiography, Non-Destructive Testing (other than radiographic).–*Robert Trochet.*

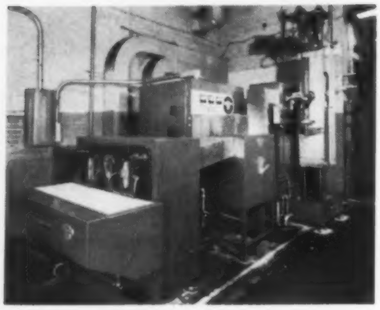
Operational Calculus – JAN MIKUSINSKI, Professor of the University of Warsaw. 495 pages. Pergamon Press, Inc., 122 East 55th Street, New York 22, New York. 1959. $15.00.

This presentation of the formulae of the operational calculus, especially in their electrotechnical applications, will doubtless find favor with electrical engineers and circuit designers.

Heat Conduction in Solids, 2nd edition – H. S. CARSLAW and J. C. JAEGER. 510 pages. Oxford University Press, 417 Fifth Avenue, New York 16, New York. 1959. $13.45.

This book is probably the most complete, concise and up-to-date treatise on heat conduction available today. It is a mathematical treatment, not a handbook, and its use is not recommended for those without a working knowledge of the calculus and differential equations.

NEWS of the INDUSTRY



Induction heating conserves valuable space

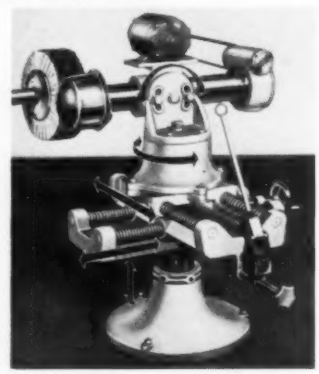
It is a well-known fact that induction heating equipment generally will occupy less space than conventional heat-treating equipment and, with plant space at a premium, how much less space can be the all-important question.

Induction Heating Corp. of Brooklyn, N.Y., has the answer. Ther-Monic has just completed installing a complete high-frequency induction heat-treating shop in the corner of a well-known printing machinery manufacturer's plant, and all the equipment occupies an area only 10 feet by 20 feet. To duplicate output of the shop shown in the photo with conventional heat-treating equipment would occupy space many times that small area. Yet the fully-equipped shop is able to process all hardening jobs, from cams and gears up to inking rollers that are six feet long and 10-in. in diameter.

From left, here are the various pieces of equipment shown which Induction Heating Corp. has furnished two position quench type work station, radio frequency power transfer switch-gear, vertical progressive scanning machine, and "C" series induction generator.

CIRCLE 24 READERS SERVICE CARD

Inexpensive, versatile buffer-grinder



Versatile, new equipment which will handle practically any buffing or grinding job in the average plant is being produced by Murray-Way Corporation, Birmingham, Michigan, designers and builders of automatic polishing and buffing equipment and production lines. The new machine, known as the Han-D-Matic, consists of a standard low cost basic pedestal and spindle unit with a wide selection of optional, interchangeable components which will accommodate practically any shape work-piece.

The Han-D-Matic is a quality built, heavy production type unit, specially designed for use with the company's standard line of polishing equipment. On production tests the Han-D-Matic has proved capable of turning out uniformly better quality work, faster and with less operator hazard and fatigue than was previously possible. In fact, one operator can easily service two or more Han-D-Matics in some cases.

CIRCLE 25 READERS SERVICE CARD

Free samples of new oil-grease absorbent

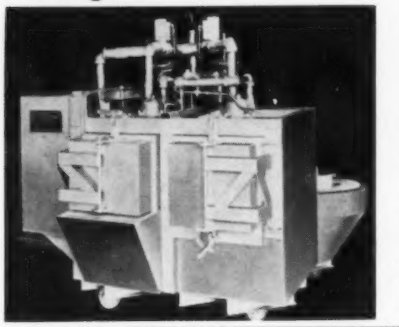
Free samples of their new Oil Spunj, a specially processed sanitary mineral clay for absorbing oil and grease, have just been offered by Canfield Oil Co., Cleveland 27, Ohio.

Oil Spunj is processed in granular form. Spread on wood, metal, or concrete floors, just 1/8" thick, it absorbs soluble oil, lubricating oil, grease, acids, and chemicals.

CIRCLE 26 READERS SERVICE CARD

CIRCLE 27 READERS SERVICE CARD

New Kozma aluminum melting furnace



A new aluminum melting furnace, Model RSHCH, especially designed for use with aluminum die casting machines is announced by the J. A. Kozma Company, 2471 Wyoming, Dearborn, Michigan.

The manufacturer claims that this new furnace is unequalled for the production of low porosity aluminum castings. The exclusive Kozma "Pre-Temp" charging and sub-surface metal flow principles of design virtually eliminate hydrogen pick-up and oxide inclusions, keeping metal at an extremely high purity level. Performance has been so outstanding that manufacturers of die cast machines and a leading producer of aluminum are recommending the Model RSHCH furnaces particularly where highest quality metal is a necessity.

The high purity is attained by the unique "Pre-Temp" charging knee with its carefully engineered position angle. This prevents the aluminum ingot from entering the bath until it has reached a plastic state. Pre-heating of the ingot is approximately 70% of the melting point at which heat the ingot deforms and is allowed to slide into the bath with virtually no increase in surface area. To further insure metal purity, zone dividing walls extend below surface of the bath which eliminates transfer of surface oxide film to the dipwell.

CIRCLE 28 READERS SERVICE CARD

(*Continued on page 27*)

A.F.S. 1960 Castings Congress in Philadelphia

Philadelphia's Convention Hall will be the site of the 1960 Castings Congress and Exposition to be held May 9-13 sponsored by the American Foundrymen's Society, the international technical society of the metal castings industry. Coming at a time when the foundry industry is already embarking on major modernization and expansion programs, AFS officials predict the 1960 show will surpass all previous exhibit and attendance records.

Industry observers predict a $13 billion castings output in the next two years. In this same period, it is estimated industry purchases of foundry equipment, materials and supplies will exceed the $5 billion mark. Tonnage estimates for ferrous castings exceed 35 million while non-ferrous casting tonnage is expected to hit well over 1.5 billion pounds.

CIRCLE 29 READERS SERVICE CARD

ADVERTISERS INDEX

CIRCLE 30 READERS SERVICE CARD

PEOPLE in DIE CASTING

■ The appointment of **Harry W. Buchanan** as a vice president of Metal & Thermit Corporation has been announced by H. E. Martin, president. Mr. Buchanan will retain his present assignment as manager of the general sales department. He is responsible for the direct selling and distribution of the company's manufactured products, including supervision of regional managers.

Mr. Buchanan was appointed manager of the general sales department in mid-1959. Prior to this he was sales manager for M & T chemicals, metals, and plating products. He joined the company in 1947 as a chemical engineer.

■ **John D. Dewhurst,** president of Arrow Tool Company of Wethersfield, Conn., and secretary of the National Tool & Die Manufacturers Association, has been appointed for a two-year term to the Federal Committee on Apprenticeship by Secretary of Labor James Mitchell. His term begins January 1, 1960. The committee serves as an advisory body to the Bureau of Apprenticeship and Training of the Department of Labor and is the oldest advisory committee in the Federal government with a continuous existence back to 1934. The group consists of 10 men, five from management and five from labor.

KRAUSE

MAGNUSSEN

■ The appointment of **Ray Krause** as vice president in charge of engineering was announced by Lester Castings, Inc., of Bedford, Ohio. Krause worked for Skil Tool & Die Co. and National Malleable & Steel Castings Co. before he joined Lester Castings in 1958. A native Clevelander, Krause received his engineering training at Case Institute of Technology.

■ **Henry T. Magnussen,** for many years an official of the Lindberg Engineering Company and the Lindberg Steel Treating Company of Chicago, was named advisor to Niels Andrew Olsen, Director Metal Working Equipment Division, Business and Defense Services Administration, United States Dept. of Commerce. Mr. Magnussen, who brings to the Division an extensive background of training in the industrial heating equipment and related metal working industries, comes to BDSA under an arrangement by which industry makes available the services of executive personnel for temporary duty without compensation from the Government.

■ Retirement of two Koehring Company Corporate officers has been announced by Julien R. Steelman, Koehring President. **F. H. Heine,** 70, Vice President in charge of Foreign Operations, retired at the end of January; and **P. P. Graser,** 69, Secretary-Treasurer, retired February 16. In announcing the retirement of Heine and Graser, Steelman said: "While we will miss their advice, counsel, and contribution to the company's achievements in the years ahead, we all know that they have richly earned their retirement and hope that they thoroughly enjoy it."

■ Latrobe Steel Company has announced two promotions on its technical staff under the direction of Vice President Stuart Fletcher, vice president-technical director. **David P. Hughes** has been appointed assistant to Mr. Fletcher and **Peter Leckie-Ewing** has moved into Mr. Hughes' position as manager of technical services.

■ **Dr. Walter A. Dean,** a recognized industry authority on light metals alloy and process developments, has been named assistant director of research for Aluminum Company of America. Dr. Dean, Alcoa's development metallurgist, metallurgical division, since 1958, succeeds William T. Ennor, who is retiring, as announced earlier this month.

■ **R. J. Smith** has been appointed Manager of Die Castings of the C. M. Hall Lamp Company of Detroit, Michigan. Smith was formerly associated with the Ainsworth-Precision Castings Company as Chief Engineer of the Die Casting Division.

CIRCLE 31 READERS SERVICE CARD

INDUSTRY

ASTE 1960 Tool Show

More than 900 new ways to increase productivity in America's metalworking plants will be premiered at the American Society of Tool Engineers' 1960 Tool Show in Detroit, April 21 to 28. Harry E. Conrad, executive secretary of ASTE, said the exposition at the Detroit Artillery Armory will contain over 6,000 examples of up-to-date machines, tools and manufacturing equipment worth $15,000,000.

According to a survey taken recently by the Society among the 530 exhibitors, 1,300 products to be displayed are new in the last year. The Armory exhibit area covers seven acres, equivalent to the space occupied by six football fields.

CIRCLE 32 READERS SERVICE CARD

SDCE SUPPORTING COMPANY MEMBERS

SUSTAINING MEMBERS

American Mold Engineering Co.
Atols Tool & Mold Corp.
Braeburn Alloy Steel Corp.
Cast-Master, Incorporated
Chrysler Casting Plant, Chrysler Corporation
Clinton Engines Corp.
Congress Die Casting Division, The Tann Corp.
Crucible Steel Company of America
Cuyahoga Industries
Dodge Steel Company
Double A Products Company
J. R. Elkins, Inc.
Process Development Section
General Motors Corporation
Kux Machine Co.
Latrobe Steel Company
Lester Engineering Co.
Permanent Mold Die Co., Inc.
Reed-Prentice Division, Package Machinery Co.
Universal Die Casting Division,
Hoover Ball & Bearing Co.

COMPANY MEMBERS

All State Industries, Inc.
Aluminum Die Cast Foundries, Inc.
Atlantic Chemicals & Metals Co.
B & K Tool Co.
B & T Machinery Company
Briggs & Stratton Corp.
Central Die Casting & Mfg. Co., Inc.
H. Cohn & Sons
Columbia Engineering Co.
Conneaut Die Casting Co.
Detroit Mold Engineering Co.
Disdie Steel, Incorporated
Dominion Die Casting Ltd.
Dort Manufacturing Co.
Johnson Motors, Outboard Marine Div.
Girard Mfg. Company
Grand Rapids Die Casting Co.
Gries Reproducer Corp.
Guild Platers Co., Inc.
Henning Bros. & Smith, Inc.
Holland Die Casting Co., Inc.
E. F. Houghton & Co.
Irrigation Equipment Co., Inc.
Lake Erie Engineering Co.
R. Lavin & Sons, Inc.
Lindberg Engineering Co.
Lindberg Steel Treating Co.
Martin Grinding & Machine Works, Inc.
Northern Tool & Die Co.
Ostrom Tool Company
Prospect Die & Mold, Inc.
Quad-City Die Casting Co.
Roth Smelting Company
Universal Cyclops Steel Corp.
Hawthorne Works, Western Electric Co.
Wabash Smelting Inc.
Western Electric Co., Inc. (Baltimore)
Wico Electric Co.
Charles Zapf & Co.

DIE CASTING SERVICES AND PERSONNEL OPPORTUNITIES

Space in this section is available at $10.00 per column inch (1" x 2¼") or any fraction thereof, payable in advance.

Closing date: 15th of month preceding publication.

To answer Box number advertisements, address responses to: Box _____, Die Casting Engineer, 19382 James Couzens Highway, Detroit 35, Michigan.

DIE CAST DIE DESIGNER, experienced in aluminum product development. Large progressive company, excellent fringe benefits. Write experience resume to Box 118.

METALLURGIST WANTED with degree and three years experience in aluminum die casting field. Large progressive company in midwest, fringe benefits, modern plant. Send resume to Box 119.

SALESMAN ALREADY COVERING DIE CASTING ACCOUNTS to sell line of ejector pins, etc. on commission basis. Territories open: New England; New York; New Jersey; Northwestern New York; Pennsylvania; Chicago; Cleveland. Write Box 120.

■ A convenient slide rule comparator, listing complete details on office copying machines made by ten different manufacturers, is available free from Dept. S9-462, **Minnesota Mining and Manufacturing Co.**, 900 Bush Avenue, St. Paul 6, Minnesota.

CIRCLE 36 READERS SERVICE CARD

Technical Literature

▪ A new aluminum alloy brochure has been prepared by **U. S. Aluminum Reduction Co.,** East Chicago, Ind. The brochure is divided into three sections. The first section is a unique line chart which cross references pertinent chemical and physical specifications of all the common alloys. The second section is a table of heat treatments and the typical mechanical properties which will result from their application. The third section lists other USCO products used in the foundry industry.

CIRCLE 40 READERS SERVICE CARD

▪ A new 40-page catalog on machinery and machinery systems for metal surface processing; cleaning, washing, rinsing, drying, spraying, and flow and dip coating; is now available from the **Ransohoff Company** of Hamilton, Ohio. The new publication illustrates and describes Ransohoff design drum-type machines, conveyor machines and systems, monorail machines, Ransomatics, and complete automatic finishing systems.

CIRCLE 41 READERS SERVICE CARD

▪ A new metal cleaning handbook presenting over one hundred types of equipment and techniques for the cleaning and preparation of metal surfaces has been released by the **Equipment Division of Magnus Chemical Company, Inc.,** Garwood, New Jersey. The 32-page handbook covers both the basic factors in metal cleaning and specific methods to meet a variety of cleaning problems, including degreasing, decarbonizing, washing, bonderizing, stripping, drying, blackening, phosphatizing, rust proofing, pickling and coating. Various sections cover analyzing of cleaning problems and the subsequent selection of the correct chemical method and equipment for the individual job.

CIRCLE 42 READERS SERVICE CARD

▪ The last word on recent developments in hardening, brazing, soldering, forging and annealing by Ther-Monic induction heating equipment has been incorporated into a new 52-page catalog-handbook just issued by **Induction Heating Corporation,** Brooklyn, New York, manufacturers of induction and dielectric heating equipment. The Ther-Monic handbook is illustrated with "how it's done" photos, and it contains up-to-date case histories.

CIRCLE 43 READERS SERVICE CARD

▪ Hannifin's Bulletin 235 covers the Alternate Bases and integral Speed Control Section for Series "CC" 4-way directional air control valves recently introduced by **Hannifin Company,** Des Plaines, Illinois, a division of Parker-Hannifin Corp. The piping versatility obtainable with the new "Universal" and "Gasket Mounted" bases is discussed, along with a description of the integral Speed Control Section and its operation. Dimensions and specifications for the new bases and integral Speed Control Section are also included.

CIRCLE 44 READERS SERVICE CARD

Expires 5/15/60 **DIE CASTING ENGINEER** March 1960

Name.. *Position*..

Company.. *Kind of Business*..

Street..

City.. *Zone*.............. *State*..............................

Please send me information on items circled below.

(These are KEY numbers, not page numbers)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112
113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128
129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144

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